

American POTATO JOURNAL

Volume 30

August 1953

Number 8

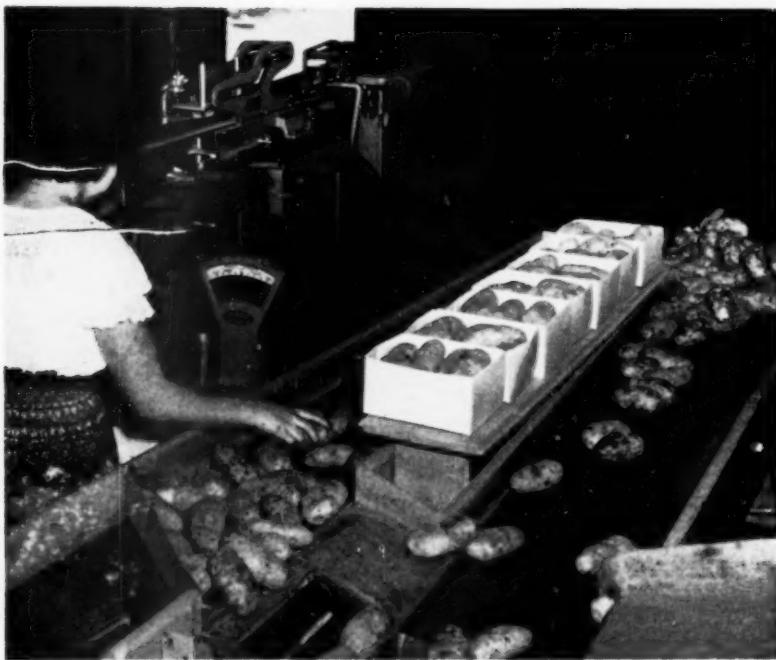
CONTENTS

Drying Tests with Washed Late-Crop Potatoes in the Red River Valley, 1950-1951— <i>J. M. Lutz, G. B. Ramsey, A. H. Glaves and John Strait</i>	179
Ring Rot Survey, 1940-1951— <i>H. M. Darling</i>	184
“Redburt” : A New Potato Variety— <i>Obert Grover and Orrin C. Turnquist</i>	186
Leafroll Control by Use of Insecticides— <i>K. H. Fernow and S. H. Kerr</i>	187

POTATO NEWS AND REVIEWS

Virus Tested Potatoes in Scotland— <i>Sir James Denby Roberts</i>	197
---	-----

Official Organ of
THE POTATO ASSOCIATION OF AMERICA
NEW BRUNSWICK, NEW JERSEY



Why Prepackaging Has Replaced Bulk Selling . . .



Bulk selling of fresh potatoes has always been freighted with tremendous wastes in shipping, in wholesale distribution and at the retail level. Quality generally has been fair to poor and service to the retail consumer practically non-existent. Prepackaging has materially changed this by eliminating the major wastes in shipping and handling . . . improved quality through proper selection and refrigeration . . . facilitated efficient self-service of pre-weighed, pre-priced potatoes. EXACT WEIGHT Scales were one of the pioneers of this great change . . . are today the most popular pre-determined weight scales in the industry. Write for details covering the proper units for your business.

*"Sales and
Service
from
Coast
to
Coast"*

EXACT WEIGHT SCALES

BETTER QUALITY CONTROL

BETTER COST CONTROL

THE EXACT WEIGHT SCALE COMPANY

921 W. Fifth Ave., Columbus 8, Ohio
2920 Bloor St., W • Toronto 18, Can.

Stop Potato Blights at Lower Spray Cost

Use Du Pont PARZATE® *Fungicide*

Now you can stop both early and late blight and protect your crop all season long . . . with Du Pont "Parzate." It does the job better and at low cost, without burning or stunting the plants. "Parzate" will stand up under the worst blight conditions.

You get all these advantages with "Parzate"

- Thorough control of early and late blight.
- No stunting of plants. Vines reach maximum growth.
- Control disease with this one product all season.
- Avoid rot damage with complete blight control.
- Roguing for virus is easier. Doesn't mask foliage.
- You get more No. 1 potatoes at lower spray cost.

Two Handy Formulations

"Parzate"
Liquid
(Nabam)

"Parzate"
Dry
(Zineb)



BETTER THINGS FOR BETTER LIVING
THROUGH CHEMISTRY

Try this new fungicide . . . DU PONT MANZATE®

New "Manzate" fungicide is especially effective where early blight and late blight attack your potatoes at the same time. It is the latest in the Du Pont family of dithiocarbamate fungicides which includes "Parzate." Try "Manzate" this season . . . it, too, is easy on the crop but tough on disease.

See your dealer for "Parzate," "Manzate" and other proven Du Pont pest control products. Ask him also for informative booklets — Du Pont, Grasselli Chemicals Dept., Wilmington, Del.

American Potato Journal

PUBLISHED BY
THE POTATO ASSOCIATION OF AMERICA
NEW BRUNSWICK, N. J.

EXECUTIVE COMMITTEE

Wm. H. Martin, *Editor*
E. S. Clark, J. C. Campbell, *Associate Editors*
Rutgers University, New Brunswick, N. J.

J. H. MUNCIE, <i>President</i>	Michigan State College, East Lansing, Mich.
ARTHUR HAWKINS, <i>Vice President</i>	University of Connecticut, Storrs, Conn.
R. W. HOUGAS, <i>Secretary</i>	University of Wisconsin, Madison, Wis.
JOHN C. CAMPBELL, <i>Treasurer</i>	Rutgers University, New Brunswick, N. J.
G. H. RIEMAN, <i>Past President</i>	University of Wisconsin, Madison, Wis.
CECIL FRUTCHEY, <i>Director</i>	Colorado A & M College, Ft. Collins, Colo.
N. M. PARKS, <i>Director</i>	Department of Agriculture, Ottawa, Canada
PAUL EASTMAN, <i>Director</i>	Department of Agriculture, Augusta, Maine

Price \$4.00 per year, in all countries

Entered as second class matter at New Brunswick, N. J., March 14, 1942 under Act of March 3, 1879. Accepted for mailing at special rate of postage provided for in section 412, Act of February 28, 1925, authorized on March 14, 1928.

SUSTAINING MEMBERS

H. H. ROBERTSON CO.	Pittsburgh, Pennsylvania
THE DOW CHEMICAL CO.	Midland, Michigan
STARKS FARMS INC.	Route 3, Rhinelander, Wisconsin
BACON BROTHERS	1425 So. Racine Ave., Chicago 8, Illinois
L. L. OLDS SEED CO.	Madison, Wisconsin
FRANK L. CLARK, Founder — Clark Seed Farms	Richford, New York
RED DOT FOODS, INC.	Madison, Wisconsin
INTERNATIONAL HARVESTER CO.	Chicago, Illinois
ROHM & HAAS COMPANY	Philadelphia, Pennsylvania
CALUMET DIVISION, CALUMET & HECLA, INC.	1 Calumet Ave., Calumet, Michigan
WISE POTATO CHIP CO.	Berwick, Pennsylvania
JOHN BEAN DIVISION, FOOD MACHINERY CORP.	Lansing 4, Michigan
S. KENNEDY & SONS, Growers and Shippers of Potatoes and Onions ..	Clear Lake, Iowa
MATHIESON CHEMICAL CORP.	Mathieson Bldg., Baltimore, 3, Maryland
AMERICAN AGRICULTURAL CHEMICAL CO.	Carteret, New Jersey

We welcome the above firms as sustaining members and express to them our appreciation for their interest and financial support.

DRYING TESTS WITH WASHED LATE-CROP POTATOES IN THE RED RIVER VALLEY, 1950 AND 1951^{1, 2, 3}

J. M. LUTZ, G. B. RAMSEY, A. H. GLAVES, AND JOHN STRAIT⁴

Since washing is becoming more and more a standard practice with table-stock potatoes, there is considerable interest in whether it is necessary to dry late-crop potatoes. The tests described in this report were conducted to determine the carrying quality of washed potatoes shipped late in the winter, dried by two different methods and not dried.

The three treatments used were as follows:

- A. The potatoes were not dried after washing but were run over a water eliminator consisting of a series of blanket-covered rollers, each of which was in contact with a steel wringer roller underneath. This removed some of the free water from the surface of the potatoes but left them still rather wet. The potato temperature averaged 38° F. after this treatment.
- B. The potatoes were passed through a warm water bath and then dried in a hot air evaporator unit. The temperature, after drying, averaged 51°.
- C. The potatoes were dried in the hot air evaporator unit. After this drying, the potato temperature averaged 44°.

MATERIALS AND METHODS

Descriptions of Drier and Treatments

The drier used, which was developed by the Agricultural Engineering Division of the University of Minnesota, consisted of 3 principal parts: (1) a warm water bath; (2) a furnace for heating the water; and (3) an evaporating chamber. The potatoes were washed in a conventional cold water washer which consisted of a series of brushes underneath and sprays overhead. Those to be dried by treatment B were then passed through the warm water bath maintained at 120° F. and then through the evaporating chamber. The function of the warm water bath was to heat the potatoes to increase subsequent evaporation of the water in the evaporating chamber. The potatoes remained in the warm water bath 2 minutes and in the evaporating chamber 5 minutes. The warm water bath was heated by circulating the water through 3 banks of coils in an oil-fired furnace. A fan with forward curved blades circulated 2000 c.f.m. of air from the outside, the shipping room, and the combustion chamber of the furnace through the evaporating chamber, counter to the flow of

¹Accepted for publication May 15, 1953.

²The authors wish to acknowledge the assistance of the following: Herbert Findlen, who helped in the preparation of the tests; M. A. Smith, who assisted with the inspection of the potatoes; and The Red River Valley Potato Growers' Association, which furnished the potatoes used in this test.

³Approved as Scientific Journal Series Paper No. 2290, Minnesota Agricultural Experiment Station.

⁴J. M. Lutz, Senior Horticulturist, G. B. Ramsey, Principal Pathologist, Division of Handling, Transportation, and Storage of Horticultural Crops, A. H. Glaves, Agricultural Engineer, Division of Farm Machinery, Bureau of Plant Industry, Soils, and Agricultural Engineering, A.R.A., United States Department of Agriculture, East Grand Forks, Minn., and John Strait, Assoc. Professor of Agricultural Engineering, University of Minnesota, St. Paul, Minn.

potatoes. Air temperature in this chamber ranged from 77° F. when the furnace burner was off to 133° when it was on.

The potatoes given treatment C were dried in the evaporating chamber by hot air alone with the furnace operating continuously.

Description of Potatoes Used

Six lots of potatoes (Lots 1 to 6, inclusive) were used in each test in 1950 (Tests 1 and 2) and 5 lots (Lots 7 to 11, inclusive) in each test in 1951 (Tests 3 and 4). The potatoes used in tests 3 and 4 were especially selected from lots that contained tubers affected with late blight, but those obviously affected were discarded in grading. Two 50-pound bags of each lot were used for each of the 3 treatments (A, B and C) in each test. This made a total of 44 bags (4 of each of the 11 lots) for each treatment and a total of 132 for the entire experiment.

Descriptions of the various lots of potatoes are given in table 1.

Transit and Holding Conditions

In each test, the test bags of dried potatoes were shipped in cars loaded with dried potatoes and the test bags of non-dried potatoes were shipped in cars loaded with non-dried potatoes. In test 1 shipment of the non-dried potatoes was not made until 3 days after the dried potatoes because of a transportation tie up caused by stormy weather. During this delay the test bags were surrounded with other bags of non-dried potatoes on the warehouse floor at a temperature of 37° F. In all other tests both dried and non-dried test bags were shipped either on the same day or within 2 days of each other. The cars in test 2 were shipped under standard ventilation. In all other tests, they were shipped under Carriers Protective Service (C. P. S.).

Weight loss and condition were determined by examining half of each sack soon after arrival in Chicago and the other half of each sack after a 1-week holding period at 70 to 72° F. to simulate store conditions.

Temperatures in transit, shipping dates and inspection dates are given in table 2.

RESULTS

Weight Loss

As shown in table 3, weight loss in transit was low regardless of method of drying. However, it was significantly higher in the dried than in the non-dried lots. Apparently the extra handling involved in drying caused an increase in skinning and minor bruises, making the potatoes more subject to weight loss.

Damage Due to Bruising

Damage due to bruising was determined in 1950 only. There was no significant difference among the 3 treatments.

Decay

Decay (mostly *Fusarium* dry rot) in 1950 was very slight in all treatments, and there was no significant difference between them. In 1951, lot No. 9 had an appreciable amount of late blight rot on arrival in the potatoes that were not dried or were dried with warm water and warm air (Treatments A and B). However, this lot when dried with warm air only (Treatment C) had a very small amount of late blight

TABLE I.—Prescription of potatoes used in drying tests.

Lot No.	Variety	Maturity	External Quality	Defects before Grading		Grade When Packed
				Practically free.	Practically free.	
1	Red Pontiac	Well-matured	Exceptionally good			U.S. No. 1
2	Pontiac	Fairly well-matured	Slightly above average	Fairly free.		U.S. No. 1
3	Pontiac	Immature	Poor to fair	Considerable skinning and bruising; appreciable scald spots; 5 per cent affected with <i>Fusarium</i> dry rot; and a trace with ring rot.		U.S. No. 1
4	Triumph	Fairly well-matured	Poor to fair	Considerable bruising; a rather high percentage of tubers affected with ring rot at time of storage but this dried out during storage period so there was no active ring rot at grading; and about 1 per cent <i>Fusarium</i> dry rot.		85 per cent U.S. No. 1
5	Triumph	Fairly immature	Fair	High percentage of tubers bruised and with scald spots. About 10 per cent of tubers affected with <i>Fusarium</i> dry rot.		80 per cent U.S. No. 1
6	Irish Cobbler	Immature	Fair	Fairly free.		U.S. No. 1
7	LaSalle	Mature	Fair	2.5 per cent of tubers affected with late blight.		80 per cent U.S. No. 1
8	Pontiac	Fairly mature	Fair	3 per cent of tubers affected with late blight.		80 per cent U.S. No. 1
9	Satapa	Fairly mature	Very poor	1.2 per cent of tubers affected with late blight.		80 per cent U.S. No. 1
10	Triumph	Fairly immature	Fair to poor	18.4 per cent of tubers affected with late blight; and a very high percentage of potatoes bruised.		80 per cent U.S. No. 1
11	Irish Cobbler	Fairly mature	Fair	1.6 per cent of tubers affected with late blight.		80 per cent U.S. No. 1

TABLE 2.—*Transit temperatures, shipping dates, and inspection dates.*¹

Treatment	Test 1 (1950)			Test 2 (1950)		
	Temper- ature ° F.	Shipping Date	First Inspection Date	Temper- ature ° F.	Shipping Date	First Inspection Date
A (Non-dried potatoes).....	37	Mar. 9	Mar. 14	41	Apr. 1	Apr. 5
B Potatoes treated in warm water and dried in warm air).....	53	Mar. 6	Mar. 13	47	Mar. 30	Apr. 5
C Potatoes dried in warm air).....	51	Mar. 6	Mar. 13	45	Mar. 30	Apr. 5

Treatment	Test 3 (1951)			Test 4 (1951)		
	Temper- ature ° F.	Shipping Date	First Inspection Date	Temper- ature ° F.	Shipping Date	First Inspection Date
A (Non-dried potatoes).....	42	Mar. 9	Mar. 13	43	Mar. 13	Mar. 19
B Potatoes treated in warm water and dried in warm air).....	47	Mar. 9	Mar. 13	50	Mar. 13	Mar. 19
C Potatoes dried in warm air).....	46	Mar. 9	Mar. 13	48	Mar. 13	Mar. 19

¹In all tests second inspection was 7 days after first.

rot. None of the other 4 lots exhibited an appreciable amount of late blight rot on arrival despite the fact that potatoes were especially selected from bins in which some late blight occurred.

Practically no late blight was found in any lot after a 1-week holding period. Apparently the lesions had dried up in some and in others late blight was followed by bacterial soft rot.

Firmness and Sprouting

In test 1 the potatoes dried with warm water and warm air (Treatment B) were noticeably softer than the others after the 1-week holding period.

In tests 1 and 2 the sprouts were slightly longer and more numerous after the holding period on the dried potatoes than on the non-dried potatoes — a reflection of the slightly higher transit temperature of the dried potatoes as shown in table 2.

Moisture on Potatoes

The non-dried potatoes in test 2 were moist on arrival. All others in this test and all potatoes in the other 3 tests were dry on arrival.

Internal Black Spot

In test 3 the Irish Cobbler potatoes dried by either method showed more internal black spot than the potatoes that were shipped wet.

TABLE 3.—*Influence of drying methods on weight loss and condition of potatoes.*

Year and Type of Damage	Loss from Indicated Drying Method			Least Difference Required between Drying Methods for Significance at 5 Per cent Level
	None	Warm Water and Warm Air	Warm Air Only	
1950: ¹	Per cent	Per cent	Per cent	Per cent
Weight loss in transit.....	0.25	0.62	0.47	0.16
Damage due to bruising, on arrival.....	3.07	4.55	3.06	NS
Damage due to bruising, after holding.....	2.32	3.80	2.60	NS
Decay ² , on arrival.....	0.22	0.28	0.25	NS
Decay ² , after holding.....	0.48	0.48	0.90	NS
1951: ³				
Weight loss in transit.....	0.18	0.56	0.44	0.13
Fusarium dry rot, on arrival.....	3.02	0.52	0.92	NS
Fusarium dry rot, after holding.....	0.60	0.92	0.26	NS
Late blight rot, on arrival.....	2.24	2.52	0.28	NS
Late blight rot, after holding.....	0.14	0	0	NS
Bacterial soft rot, on arrival.....	3.28	2.64	2.64	NS
Bacterial soft rot, after holding.....	4.16	4.78	2.94	NS

¹Average from 2 tests with 6 lots each and 2 bags in each lot. Each figure is thus based on 24 bags.

²Mostly fusarium dry rot.

³Average from 2 tests with 5 lots each, and 2 bags in each lot. Each figure is thus based on 20 bags.

CONCLUSIONS

These tests involving 11 lots of potatoes during a 2-year period, indicate that drying Red River Valley storage potatoes after they are washed for market is not necessary except possibly for some lots affected with late blight or other decays. Potatoes from 1 lot had an appreciable amount of late blight rot on arrival when not dried, but very little when dried with warm air. Weight loss and in some cases sprouting were

greater in the dried than in non-dried potatoes. Transit temperatures of the dried potatoes were higher because of the initial higher temperature.

These experiments were conducted under relatively dry atmospheric conditions. It is entirely possible that similar results would not have been obtained under more humid conditions. It should also be pointed out that these tests were conducted with storage potatoes and that similar results would not necessarily have been obtained with early-crop potatoes.

RING ROT SURVEY, 1940-1951¹

H. M. DARLING^{*2}

Since the time ring rot was found in this country about 20 years ago considerable attention has been directed to the production of ring rot free seed as a means of controlling the disease. Certification officials, as well as many others interested in the potato industry, have often discussed numerous aspects of the problem and have felt that some factual data on its incidence would be highly desirable. It was decided that inspection records obtained by the certification agencies would afford a reliable source of information in making estimates of its occurrence and would also be of use in evaluating the control practices in use during the last 11 years. A report covering the years 1940 to 1947 has been published (1).

Data submitted by all the seed-producing states in the United States and Canada since 1940 show an over-all incidence of 7.8 per cent. It is quite obvious that ring rot has increased during the last few years, moving from a five-year average (1940-1945) of 5.4 per cent to an average of approximately 9.2 per cent since 1946. A somewhat alarming annual average of 14.8 per cent occurred in 1946, but was reduced by half to 7.3 per cent the following year. Otherwise the percentages reported since 1947 have fluctuated only slightly from year to year but still remain above the average incidence of the previous five year period. Apparently there does not appear to be any consecutive series of years during which the disease built up in prevalence since the survey was started in 1940. The shifts that have occurred appear to move more or less at random each year.

As might be expected, considerable variation exists in the percentage reported between states, reaching as much as 20 per cent. Similarly, extreme shifts were also reported by individual states between certain years, regardless of the number of acres grown. In this respect it is interesting to note that 10 of the 20 states reporting produce about 90 per cent of all the certified seed grown, yet report an average of 1 per cent less ring rot than all the remaining states combined. The range in prevalence over all the states appears to be an individual matter, neither associated with geographic location, the number of acres grown, or bushels produced. Most states reported little actual loss in yield or quality because of the disease, but it must be remembered that the reports are based on certified seed inspections and not on observations in commercial plantings of potatoes produced for table use.

¹Accepted for publication April 14, 1953.

²In charge Seed Certification, University of Wisconsin, Madison, Wis.

The data in the survey point rather conclusively to the fact that the incidence of ring rot is not being reduced. Correspondence and discussions conducted during the course of the survey point to several factors. Without exception all states reported strict adherence to a zero or no tolerance in their classification work, and also reported control programs based on (1) the use of clean seed and (2) employment by growers of a sanitation program. There was unanimous agreement on the use of ring rot-free seed, and several methods of producing it were suggested, depending upon the local situation. Agreement was quite general on the employment of a sanitation program to prevent contamination, but on this point several different opinions were expressed. The majority felt that contamination occurred mainly in and around the warehouse and were quite critical in appraising several procedures that might be followed to prevent it. Numerous disinfectants were suggested for use under a remarkably wide range of conditions. Still others felt that recognition of the disease, both in the field and in storage, was also an important phase of the general program. It would appear then that most states have decided that ring rot cannot be completely eradicated by regulation and inspection alone and are, therefore, recommending that various precautionary measures be taken to prevent contamination of healthy seed stocks.

The data and opinions gathered during the survey also point rather clearly to the fact that the over-all problem of controlling ring rot is not a static one. Although a severe general outbreak of the disease was not reported during the 11 years covered by the survey, there were no assurances from any source that serious damage may not develop. In individual instances serious loss was reported, enough to afford ample justification for additional study and research. It was suggested by some that the ring rot problem in Europe, where the disease apparently originated, is not serious, mainly because they develop ring rot-free seed sources and practically eliminate contamination by using uncut seed in all their growing operations and do practically all their seed work by hand. By comparison, ring rot-free sources of seed are also being produced in this country, but by the time many of these seed sources reach a rather large volume they frequently become contaminated. This is because the disease is spread so easily in so many ways by the different machines used in planting, harvesting, and grading the crop. Still others pointed to the value of an immune variety, that educational work had contributed much towards control, that better disinfectants are needed, and that basic research on many phases of the causal organism itself is needed. Obviously the disease is not going to be eradicated by regulation, therefore, we must learn to "live" with it and continue to improve our control practices in the most economical way possible.

LITERATURE CITED

1. Darling, H. M. 1948. Ring rot survey 1940-1947. *Amer. Potato Jour.* 25: 44-47.

*The data for this report were collected by the writer as Chairman of the Seed Certification Committee of the Potato Association of America. Grateful acknowledgment is made to the other committee members, W. H. Dunlap, Paul Eastman, Marx Koehnke, J. W. Scannell, and A. G. Tolaas, and to the numerous certification officials in the United States and Canada for their excellent co-operation in furnishing data for their states.

"REDBURT": A NEW POTATO VARIETY¹

OBERT GROVER AND ORRIN C. TURNQUIST²

The variety Redburt was selected in 1949 from a field of Satapa at the Obert Grover farm at Glyndon, Minnesota. The variety is a deeper red color and more elongated than the Satapa variety out of which it was found, more nearly resembling the Pontiac in type. There appear to be fewer oversize tubers than the Pontiac and fewer undersize than the Satapa. Two commercial plantings were made of Redburt in 1952. In Clay County, Minnesota (Red River Valley), Redburt planted two weeks later than Pontiac yielded 350 bushels per acre, matured 10 days earlier, and equalled the Pontiac in yield. In Clearwater County, Minnesota, 20 hundred pounds of seed planted on slightly over three acres produced 1032 bushels for a yield of 300 bushels per acre. Less profuse vine growth and more maturity at harvest made for easier mechanical harvesting of Redburt than Pontiac in 1952.

Several samples of Redburt were distributed for culinary tests. The specific gravity of the samples tested averaged 1.089. Reports indicated the general desirability to be good to excellent. The tubers retained their normal shape after boiling with skins removed and the texture appeared to be dry and mealy. The color was indicated as generally attractive although the flesh was indicated as cream to yellowish after boiling.

BOTANICAL DESCRIPTION

Plants medium in size, spreading; stems thick, prominently angled; nodes slightly swollen, dark green; internodes pigmented, reddish purple; wings prominent, straight, double, green; stipules medium to small, spreading, green slightly pubescent; leaves medium size, closed, green; midribs pigmented, pubescent; petioles pigmented, pubescent; terminal leaflets medium, ovate lobed; primary leaflets medium, ovate lobed; four to five pairs; petioles green but pigmented at base; secondary leaflets many, on midrib between pairs of primary leaflets, at junction of midrib and petioles; tertiary leaflets many; inflorescence medium branched; leafy bracts few, single wing; peduncles medium in length, in axils of petioles and main stem, pigmented, slightly pubescent; pedicels medium in length, pigmented, pubescent; abscission layer, dark purple.

Flowers many, not too lasting; calyx lobe tips long awl-shaped, pigmented, pubescent; corolla medium in size (Diameter 27-32 min.) light purple; anthers orange, conic; pollen scant; style medium length, straight; stigma globose, green.

Tubers large, oblong, blunt at ends, medium thick; skin smooth, self colored, red; Eyes medium deep, red, medium in number, uniformly distributed; eye brows long, curved; flesh white; specific gravity high.

Since discovered as a single tuber unit in 1949, Redburts have been grown and increased by Obert Grover, Glyndon, Minnesota, and Delbert Darst, Bagley, Minnesota. The variety was named in 1952.

¹Accepted for publication April 14, 1953.

²Potato grower of Glyndon, Minn., and Extension Horticulturalist, St. Paul, Minn.

LEAFROLL CONTROL BY USE OF INSECTICIDES¹K. H. FERNOW² AND S. H. KERR³

Recorded attempts to control the spread of potato leafroll virus by insecticidal control of the vectors show varied and erratic results. Older materials such as rotenone and nicotine sometimes depressed the amount of early season virus spread but these insecticides have not appeared to be very effective (2) (6) (11). In some of the trials with DDT and parathion, authors have reported unsatisfactory control or even an increased amount of leafroll where these insecticides were used (3) (4) (7), but use of DDT and phosphate compounds is suggested as helpful by others (5) (8) (9) (12). Some of the reported tests have been inconclusive, however, because there was insufficient leafroll to show significant differences (1) (10).

The following tests emphasized the use of the effective phosphate insecticides. To obviate the danger of inconclusive results where no significant disease control data are obtained in either direction the experimental design included: (1) two varieties, one very susceptible to leafroll spread, the other resistant; (2) an abundant source of inoculum placed in a known arrangement so that all treatments would be equally subjected to its influence and so that these diseased source plants could be completely discarded later in order not to complicate the interpretation of results; (3) virus free seed of each variety so that all disease encountered would be the result of dissemination. Consideration also was given to the possibility of insuring the presence of vectors by artificial infestation.

In such experiments it is well to bear in mind that infection in rows adjacent to the leafroll inoculum may be so high that the difference between an effective insecticide and an ineffective one may not be apparent, and conversely, in rows distant from inoculum, infection may be so low that such differences can not be demonstrated. It was for this reason that the two varieties were selected and that the identity of tubers from each row in each treatment was maintained as a sub-plot.

1951 TESTS

Materials and Methods

In 1951 each plot consisted of 9 rows 48 feet long with all the inoculum in rows 1 and 9. Row 1 showed 80 per cent leafroll and row 9, 99 per cent spindle tuber with a small undetermined amount of leafroll. The plots were arranged in four parallel strips with eight plots per strip. The first and third strips were planted with Katahdin, known to be resistant to leafroll spread, and the other two strips were planted with Chippewa, known to be very susceptible to leafroll spread. The thirty-two plots were divided into four blocks with four treatments randomized in each block of each variety. The potatoes were planted May 24 and 25.

The four treatments were as follows:

1. 50 per cent DDT wettable powder 4 pounds, plus 50 per cent technical Systox, 12 ounces per 100 gallons per acre.

¹Accepted for publication May 19, 1953.

²Assoc. Professor Dept. of Plant Pathology, Cornell University.

³Assistant, Dept. of Entomology, Cornell University, Ithaca, N. Y.

2. 50 per cent wettable powder 4 pounds, plus 1.5 per cent parathion wettable powder, 1½ pounds, per 100 gallons per acre.
3. 50 per cent wettable powder, 4 pounds per 100 gallons per acre.
4. Check. Fungicide only.

All treatments had a fixed copper fungicide in the spray at each application. The materials were applied at a pressure of 300 pounds per square inch from a three row, hand-carried boom. Six applications were made starting July 10 and continuing every ten days as weather permitted, with the final spray on August 31.

Early 1951 was a poor season for the development of aphids and it was decided that artificial infestation of the plots would be attempted. On July 7 several thousand greenhouse-raised green peach aphids (*Myzus persicae* (Sulzer) were placed in the field. Each plot had two plants infested, one in an outer row and one in an inner row. Each such plant received 100 to 200 aphids. A similar artificial infestation was made again on August 14 with the outer row which was infested being opposite to the one infested July 7. There is some doubt as to whether this artificial infestation accomplished a substantial increase in the number of aphids when conditions did not favor natural development. Later in the season when conditions were more favorable for aphid development, potato aphids (*Macrosiphum solanifolii* (Kalt.) were in evidence in considerable numbers as well as *M. persicae*. The aphid counts were taken just prior to the spray applications and were made by counting the aphids on seven terminal leaflets per plot, or fifty-six per treatment, with upper, middle and lower leaves being counted in rotation on the inner rows.

At the end of the season, tuber samples consisting of twenty-eight small tubers were taken from each row of all plots, each such group of twenty-eight tubers constituting a sub-plot. These were indexed in Florida during the winter. Conditions for identification of leafroll and spindle tuber were very good.

Results

Aphid counts are given in table 1. No aphids were found June 24 or July 19.

Most of the leafroll spread was to row 2, next to the leafroll-infected row. There was also a considerable amount of spread on row 3 and row 8 but very little on rows 4 to 7. In presenting the results, rows 2, 3 and 8 have been combined and designated as exposure 1 and rows 4 to 7 are designated as exposure 2.

The actual percentages of leafroll for each exposure in each treatment are given in table 2. The percentages in each sub-plot were converted to angles following the method of Snedecor (13), and an analysis of variance was made. The analysis showed a high degree of significance for treatments, exposures, and the interactions of exposures with treatments and of exposures with varieties. The decreases in leafroll following insecticide application are presented in table 3. It is believed that the most important figures in table 3 are those for exposure 1 since it was only here that percentages were high enough to demonstrate control.

In table 3 it will be noted that none of the differences in exposure 2 was significant. In exposure 1, in the Chippewa variety each of the three insecticides was better than no insecticide. Each of the two phosphate insecticides, parathion and Systox, gave better results than DDT alone in

TABLE 1.—1951 Experiment—Aphid counts. "Each figure indicates the total number of aphids of all species found on 56 terminal leaflets."

	Date of Count		
	Aug. 9	Aug. 19	Aug. 30
Systox + DDT	0	0	0
Parathion + DDT	3	0	26
DDT alone	40	298	684
No insecticide	40	242	325

TABLE 2.—Percentages of leafroll in progeny plants

	1951-1952 Experiment			
	Chippewa Exposures ¹		Katahdin Exposures ¹	
	1	2	1	2
Systox + DDT	5.97	3.84	0.99	1.52
Parathion + DDT	9.36	4.18	5.54	0.81
DDT alone	24.41	4.49	8.17	0.27
No insecticide	35.80	1.62	8.98	0.00

¹Exposure 1: Rows near leafroll, numbers 2, 3 and 8, distance about 3 to 6 feet. Exposure 2: rows further from leaf roll, numbers 4, 5, 6, 7, about 9 to 15 feet.

NOTE: Percentages in exposure 1 are based on 12 sub-plots each, in exposure 2 on 16 sub-plots. Each sub-plot contained about 25 to 30 plants.

this variety but the difference between the phosphates was not significant. In the Katahdin variety Systox was better than DDT alone and than no insecticide. These and other data in the table support the conclusions that the incidence of leafroll was materially reduced by applications of these three insecticides and that Systox and parathion used with DDT had a greater effect than DDT alone.

Under the conditions of this experiment there was no appreciable spread of spindle tuber. The total number of spindle tuber-diseased plants was 56 out of 6211 or less than 1 per cent. These, therefore, showed no relation of distribution to treatment and very little to position.

1952 TESTS

Materials and Methods

The 1952 experimental area again consisted of four strips of nine rows each, with two strips of Katahdin and two of Chippewa. This time the inoculum was introduced only into the first and fourth strips as row 2 for leafroll and row 8 for spindle tuber. The two center strips were thus left without inoculum for the purpose of measuring the spread of leafroll in which winged aphids might be involved.

Each strip was divided into twelve plots 28 feet long. The forty-eight plots were divided into two blocks, each containing six plots of each of the two varieties in each of the two degrees of exposure.

In each of the two blocks there were two Systox plots, two parathion plots and two without phosphate insecticide and in each instance one of the two plots received DDT and the other did not. The dosages were as follows:

50 per cent Systox, 12 ounces per 100 gallons per acre.
 15 per cent parathion, wettable powder, 1½ pounds per 100 gallons per acre.
 50 per cent DDT wettable powder, 4 pounds per 100 gallons per acre.

TABLE 3.—*Decreases in leafroll content following application of insecticides in 1951.*

(Differences are expressed as average angles.)

Variety	Insecticide	Compared with	Exposure		Both Exposures
			1	2	
Chippewa	DDT	No insecticide	9.54*	-3.01	2.37
	"	"	20.32*	-3.59	6.68*
	Systox ¹	"	24.93*	-2.74	9.12
	Parathion ¹	DDT	10.78*	-0.58	4.28
	"	"	15.39*	0.27	6.75*
	"	Parathion	4.61	0.85	2.47
Katahdin	DDT	No insecticide	1.47	-0.68	0.24
	"	"	7.09	-1.73	2.05
	Parathion	"	10.34*	-2.41	3.05
	"	DDT	5.62	-1.05	1.81
	Systox	"	8.87*	-1.73	2.81
	"	Parathion	3.25	-0.68	1.00
N			12	16	28
	L.S.D. 5 per cent		8.05	6.98	4.78
Both Varieties	DDT	No insecticide	5.51	-1.84	1.31
	"	"	13.71*	-2.66	4.35*
	Systox	"	17.64*	-2.57	6.09*
	Parathion	DDT	8.20*	-0.82	3.04
	"	"	12.13*	-0.73	4.78*
	"	Parathion	3.93	0.09	1.74
N			24	32	56
	L.S.D. 5 per cent		5.69	4.93	3.38

*Significant differences.

¹Where parathion or systox is listed DDT was also used in this experiment.

TABLE 4.—*Aphids counted in 1952 experiment. (Each figure indicates number of all species on 56 terminal leaflets)*

Treatment	Date of Count						
	July 2	July 12	July 23	July 31	Aug. 13	Aug. 25	Sept. 3
Systox + DDT	1	1	2	4	1	17	2
Systox	0	1	1	0	1	0	1
Parathion + DDT	1	4	1	1	11	0	0
Parathion	1	1	0	0	10	0	0
Checks + DDT	14	11	16	30	340	94	328
Checks	11	9	12	8	12	9	31

Systox was applied every 20 days, parathion, DDT and a fungicide every 10 days. The various materials were mixed in the spray tank and applied simultaneously to the appropriate plots. Eight sprays were applied starting June 24 and ending September 4. The planting was done in the middle of May and harvesting September 16 and 17. During harvesting, 25 tubers were taken from each plot. These sub-plot samples were planted in Florida and inspected in January.

Results

Aphid populations on the plants were low throughout the season, in view of which leafroll counts were surprisingly high. Aphid counts are shown in table 4. It may be worthy of note that some aphids were found during each of the July observations whereas in 1951 none was found until August.

In presenting the results on leafroll spread it has been thought best to sub-divide the two exposure levels. Rows 1, 3, 4, 7 and 9 in the strips containing inoculum are exposure 1; rows 5 and 6 in the same strips are exposure 2; the first four rows of the plots without inoculum are exposure 3; and the last five rows farthest from the inoculum are exposure 4. It is probable that little of the leafroll in exposures 3 and 4 resulted from direct activity of wingless aphids moving from the inoculum rows. Winged aphids must have been involved but it is not known how many of the infected plants resulted from direct feeding of winged aphids and how many from the activity of wingless progeny moving from such infected plants.

The leafroll readings on the sub-plot progeny were converted to angles and subjected to an analysis of variance. Significant variances were found for:

- Exposures
- Phosphate insecticides (including no phosphate)
- Variety x exposures
- Variety x phosphate
- Exposure x phosphates
- Exposures x phosphates x variety
- Exposures x DDT

The percentage of plants showing leafroll in progeny plots is shown in table 5 and differences, expressed as angles, in tables 6 and 7. Systox and parathion gave significant reductions in leafroll in each variety in exposure 1 and in Chippewa in exposure 2. Systox also gave a significant reduction in exposures 3 and 4 in Chippewa. Although the other differences failed to reach a significant value they tend to support the conclusion that these materials were beneficial. When the two phosphate materials are considered together they gave significant reductions in all exposures in Chippewa and in exposures 1 and 2 in Katahdin.

Table 7 shows the reduction in leafroll associated with the use of DDT. In exposures 1 and 2 the trend is clearly negative, that is, the use of DDT increased leafroll. In exposures 3 and 4 the general trend is positive. Although only seven of the twenty-four differences shown in the 4 exposures reach a significant level, the trend among the remaining differences supports the conclusion that DDT was detrimental in exposures 1 and 2 where heavy local spread was taking place and beneficial in exposures 3 and 4 where there was less total spread. In this connection it should be

TABLE 5.—*Percentages of leafroll in progeny plants.*

1952 Experiment

Variety and Treatment	Per cent Infection			
	1	2	3	4
Chippewa				
Systox + DDT	28.0	9.0	6.0	2.0
Systox alone	19.2	3.0	9.5	2.8
Parathion + DDT	26.1	3.0	12.0	2.0
Parathion alone	20.4	13.0	8.5	3.6
DDT alone	85.6	59.0	9.5	4.8
No Insecticide	66.0	17.0	25.5	10.0
Katahdin				
Systox + DDT	6.0	0.0	0.0	2.0
Systox alone	7.6	0.0	0.5	0.4
Parathion + DDT	6.0	2.0	4.5	1.6
Parathion alone	3.2	0.0	0.0	4.8
DDT alone	20.0	2.0	0.5	0.8
No Insecticide	9.6	7.0	0.5	1.2

¹Exposure 1 consisted of rows 1, 3, 4, 7 and 9, row 2 being 100 per cent leaf roll and 8 containing an undetermined amount of leaf roll.

Exposure 2 consisted of rows 5 and 6, 9 to 12 feet from the leaf roll infected rows.

Exposure 3 consisted of rows 1 to 4 in the neighboring plots about 30 to 40 feet from the row showing 100 per cent leaf roll.

Exposure 4 consisted of rows 5 to 9 in the neighboring plots, about 43 to 55 feet from the leaf roll infected row.

Percentages in exposure 1 and 4 based on 10 sub-plots of 25 plants each, in exposure 2 on 4 sub-plots and in exposure 3 on 8 sub-plots.

remembered that in the 1951 experiment, where spread of leafroll was less extensive, DDT was definitely beneficial.

The spread of spindle tuber took place to a surprising extent in 1952. The average for the entire experiment was 8.8 per cent. However, the incidence of spindle tuber appeared to bear no relation to any other factor except nearness to inoculum and even that relationship was not very marked. The four most exposed rows showed 12 per cent, with less exposed plots showing 7.6, 5.6 and 8.3 per cent, respectively. Whatever vector was involved seems not to have been influenced by DDT, parathion or Systox. Circumstantial evidence leads to the suggestion that the vectors may have been goats. A large flock of these highly mobile animals kept in a nearby field for experimental purposes got through the fence on numerous occasions and fed freely and indiscriminately on potato crops.

DISCUSSION

An ideal location for the production of seed potatoes would be where no vectors occur, so that the percentage of leafroll would automatically decrease from year to year. Such locations are not outside human experience but they are not common, not accessible and it is never certain that a change of season will not alter the situation. It will therefore be necessary to produce large quantities of seed potatoes in areas like New York where, in an average year, the leafroll percentage is likely to double if no control measures are used. Actually, not every year is an average year and not every grower can count on average conditions on his farm. No very large increase

TABLE 6.—Decreases in leafroll following applications of phosphate insecticides. Half of each lot received DDT. Leafroll expressed as angles.

1952 Experiment

Variety	Insect	Compared with	1	2	3	4	All
Chippewa	Parathion	No phosphate	37.45*	25.25*	5.69	5.70	18.06*
		" "	37.10*	25.50*	6.56*	6.10*	18.45*
	Systox	Parathion	-0.35	1.25	0.87	0.40	0.39
Katahdin	Parathion	No phosphate	9.90*	7.50	-2.69	-4.20	2.05
		" "	7.75*	9.50	0.75	-0.60	3.61
	Systox	Parathion	-2.15	2.00	3.44	3.60	1.56
N			20	8	16	20	64
L.S.D.				5.83	9.23	6.52	5.21
5 per cent ..							
Chippewa	2 phosphates	No phosphate	37.28*	25.38*	6.12*	5.90*	18.20*
		" "	8.82*	8.50*	-0.97	-2.40	2.83
	Systox		26.7	-10.7	21.4	26.7	85.5
N				5.07	8.04	5.64	4.51
L.S.D.							
5 per cent ..							
Both varieties	Parathion	No phosphate	23.66*	16.38*	1.50	0.75	10.06*
		" "	22.42*	12.50*	3.66	2.75	11.03*
	Systox	Parathion	-1.25	1.62	2.16	2.00	0.98
N			40	16	32	40	128
L.S.D.				4.12	6.52	4.61	4.12
5 per cent ..							3.69

*Significant differences.

in the number or activity of vectors is needed to increase the incidence of disease many fold. A specific instance in 1952 resulted in a product which showed 45 to 70 per cent leafroll on one farm of nine fields, whereas fields planted with the same seed by the same grower on a farm about 30 miles away showed from 1 to 4 per cent. This indicates that there was nothing wrong with the seed planted or with the general program. Although this is an extreme case in an extreme year, many instances could be cited in which fields planted with good seed produced stock containing 10, 20 or 30 per cent leafroll. Similar experiences are known to have occurred in other states, specifically New Jersey and Maine.

Discovery of materials and methods which would reduce these hazards to reasonable proportions would be highly desirable even if leafroll spread could not be eliminated completely. It appears to the writers that the experiments here reported give strong indication that parathion and Systox, when used throughout the season can reduce spread of leafroll. This conclusion is not contradicted by the fact that in the two experiments approximately 3 per cent and 24 per cent leafroll were still present in exposure 1 of the Chippewa plots sprayed with Systox and parathion. These rows were deliberately subjected to a much heavier infection potential than that which would ordinarily occur in a commercial seed field. The argument may be advanced that it is spread largely by wingless aphids which have

TABLE 7.—Decreases in leafroll following DDT applications. Expressed as average angles.

(Negative values indicate unfavorable response to application)

Groups Involved	Exposures				All Exposures
	1	2	3	4	
Chippewa	-8.40*	-8.33*	6.80*	3.33	-0.93
Katahdin	-4.13	1.00	-2.29	2.07	-1.54
N	30	12	24	30	96
L.S.D. 5 per cent	4.76	7.53	5.32	4.76	4.26
Systox	-2.75	-4.00	3.49	-1.60	-0.98
Parathion	-3.85	3.25	-5.80	4.40	-0.88
No aphicide	-12.20*	-10.24*	9.06*	3.20	-1.83
N	20	8	16	20	64
L.S.D. 5 per cent	5.83	9.23	6.52	5.83	5.21
All varieties and treatments	-6.26*	-3.66	2.26	2.63	-1.24
N	60	24	48	60	192
L. S. D. 5 per cent	3.36	5.32	3.76	3.36	3.00

*Significant differences.

been controlled in these tests whereas outbreaks such as described in the preceding paragraph are caused by winged aphids. Even if one conceived that these materials may be less effective in preventing transmission by winged forms, it appears improbable that such outbreaks are caused exclusively by alatae. Sometimes they may be extremely important, but it would seem likely that usually much secondary spread by wingless aphids must also be involved. Even if none of the primary spread could be prevented, the reduction in secondary spread should be worthwhile. It also seems likely that winged aphids would be appreciably better controlled in a large field all sprayed the same than in small plots. The presence of the check plots in the experiments offers a haven for moving aphids which should bring about a greater incidence of leafroll in the treated plots, whereas the presence of the treated plots among the checks should reduce the number of vectors available for transmission in the checks. For these reasons it appears to the authors that the use of parathion should be recommended to persons wishing to grow seed potatoes in New York State with the proviso that, once started, the program should be continued until the plants are dead. The use of Systox on food plants has not been approved to date, and this material should not be used on potatoes.

With regard to the use of DDT, the experiments seem to indicate that this material may be detrimental to a good seed program, at least under some circumstances. In 1951, plots sprayed with DDT produced potatoes with less leafroll than did untreated plots, but in 1952, the use of DDT in plots where heavy spread was taking place brought about an increase in spread, while a reduction in incidence occurred where spread was not so heavy. The reason for this is not clear.

The experimental design used seems to possess definite advantages which the results illustrate. Attention may be called to the portion of the

experiment where there is a percentage of leafroll favorable to a meaningful analysis. If the rate of spread is low, more significant results can be expected in rows nearest to the inoculum and in the Chippewa variety. If very heavy spread should occur, more useful data would probably be obtained in rows farther from the inoculum and in the Katahdin variety. The original inoculum is entirely discarded. The design is not adapted to cooperative experiments where the cooperator has an interest in seed value of nearby potatoes.

Because of the gradual inactivation of parathion, as well as new growth of plants, it appears likely that there was little protective action by this material toward the end of the ten-day period between sprays. The same might be true for DDT to a lesser extent. Systox probably gave adequate protection throughout the ten-day period in 1951, but possibly not throughout this twenty-day period in 1952. If this is a reason for the failure to eliminate leafroll completely it is possible that better results might be obtained with a five- to seven-day schedule for parathion and a fourteen-day schedule for Systox.

SUMMARY

In 1951 and 1952, tests were conducted near Ithaca, New York, on the effect of insecticidal applications on the amount and pattern of spread of potato leafroll virus from known sources of inoculum. Systox was very effective in reducing disease incidence, parathion reduced virus spread almost as well, and DDT appeared most helpful where the amount of virus spread was relatively light but actually detrimental where spread was heavy.

Most of the spread occurred on rows immediately adjoining rows on which the inoculum sources was prevalent. This steep gradient of infection indicated that wingless aphids apparently were responsible for most of the spread. In rows farther from the inoculum the percentage of disease was much lower and it was less easy to demonstrate control.

Since Systox has not been authorized for use on food plants it can not be recommended at the present time. It is recommended that potato seed growers in New York use parathion at frequent intervals throughout the season and continue until the vines are killed.

LITERATURE CITED

1. Adams, J. B., and R. A. Kelly. 1950. Potato aphid control studies, 1946-1949, at Woodstock, N. B., Canada. *Amer. Potato Journal*, 27:175-182.
2. Bronson, T. E. 1945. Insecticidal control of aphids. *Me. Agr. Exp. Sta. Bull.* 438, 523-525.
3. ———, F. F. Smith, W. A. Shands, and G. W. Simpson. 1940. Control of aphids on potatoes and the spread of leafroll. *Me. Agr. Exp. Sta. Bull.* 42, 134-138.
4. Chapman, K. C. 1951. Control of aphids affecting potato crops. *Proc. 6th Ann. Mtg. N. Central States Br. Amer. Assoc. Econ. Ent.*, 15-16.
5. Christenson, L. D., and F. F. Smith. 1952. Insects and the plant viruses. Insects. *U. S. Dept. Agr. Yearbook of Agr.*, 179-190.
6. Cleveland, C. R. 1931. The relation of insects to the transmission of potato leafroll and tomato mosaic in Indiana. *Ind. Agr. Exp. Sta. Bull.*, 351:1-24.
7. Daniels, L. B. 1950. Insecticidal control of the vectors of virus diseases. *Proc. 5th Ann. Mtg. N. Central States Br. Amer. Assoc. Econ. Ent.*, P. 22.
8. Gibson, K. E., B. J. Landis, and E. C. Klostermeyer. 1951. Effect of aphid control on the spread of leafroll in potatoes. *Amer. Potato Jour.*, 28:658-666.

9. Ronnebeck, W. 1952. (German title.) Experiment on the reduction of virus infection of potato plants. *Nachrichtenblatt des Deutschen Pflanzenschutzzdienstes*, 4:189-190. (Translation by G. W. Simpson, typewritten, 1952.)
10. Shands, W. A., G. W. Simpson, P. M. Lombard, R. M. Cobb, and P. H. Lung. 1950. Control of aphids on potatoes with DDT when used with fungicides. *Me. Agr. Exp. Sta. Bull.* 480:1-41.
11. Simpson, G. W., W. A. Shands, and T. E. Bronson. 1944. Aphid biology and aphid control. *Me. Agr. Exp. Sta. Bull.* 426, 221-223.
12. _____, _____ and O. L. Wyman. 1952. How to use insecticides on Maine potatoes. *Me. Agr. Exp. Sta. Ext. Bull.* 361: 1-10.
13. Snedecor, G. W. 1946. Statistical methods. 480 pages. (Reference on p. 449).

POTATO NEWS AND REVIEWS**VIRUS TESTED POTATOES IN SCOTLAND¹**SIR JAMES DENBY ROBERTS²

Ever since the potato was introduced in Britain in the sixteenth century, it has been an important part of the diet of every one, rich or poor, and has vied with bread as the main source of energy in the daily ration. At first the potato seems to have been grown mainly as a garden crop; with the growth of the urban population, however, during the industrial revolution here in the nineteenth century it became a very important field crop, as it still is. The two world wars served to emphasize its value to all.

For a very long time it was well known to practical growers of potatoes that a stock of a particular variety gradually degenerates under ordinary field conditions, and formerly the only course taken was to accept this fact, scrap the run-out variety and hope to replace it with a similar sort newly raised from a seedling. The new variety would run for a shorter or longer period before it, too, had to be scrapped. This was an unsatisfactory state of affairs, even though it led to some exciting gambling in new varieties. Various speculative theories were put forward to explain the well known degeneration which eventually took place with all stocks, but more slowly in some parts of Britain than in others. It was realized early that some parts of the country could carry stocks for a longer time than others, and that in general the more northerly land was better in this respect than the more genial south. On this finding was based the considerable trade in Seed Potatoes that has been carried on by farmers in Scotland for a long period, and not without profit.

SCOTTISH SEED SHOWN SUPERIOR

There has been some interesting speculation how the superiority of Scottish seed potatoes came to be realized in the South. One theory is that, about the middle of last century, when farming in Britain was beginning to enter a period of depression, a number of Scottish farmers migrated to England to try their luck in the more kindly climate of the south. They took, among their other possessions, some potatoes for seed to their new farms, and soon found that the resulting crop was much heavier and healthier than those of their neighbors. They also soon found that this superiority did not last for many seasons, and they had to get fresh supplies from home every few years, in order to maintain the yields. Whether this is the right explanation or not of the spread of Seed Potatoes from Scotland, it is certain from our records, that the trade has been well established for the past hundred years. It was, too, a very welcome trade in this and many other areas, as it was soon recognized that the best ground for the raising of good seed was rather high and cold, suitable in the main for the raising of stock and fodder for the animals during the long winters. A cash crop would be very useful in such areas, and so it is no wonder that farmers there went into the growing of seed potatoes with all the enthusiasm and skill at their command.

¹Accepted for publication May 8, 1953

²Owner of Strathallan Farms, Strathallan Castle, Auchterarder, Scotland.

VIRUS DEGENERATION CAUSE DISCOVERED

Now, although it was known that some districts could produce healthy seed crops over a long period of years, it was also known that even there a stock would eventually degenerate. For a long time no satisfactory reason for this degeneration was forthcoming despite many ingenious theories. Indeed it was not until a little more than thirty years ago that virus diseases were shown conclusively to play a great, if not the whole, part in the decline of stocks. Since then a very great amount of research work has been done on plant viruses in all parts of the world, and a great deal has been found out about their effects on potato and other plants and stocks. There is still much to ascertain about the actual viruses themselves, and the findings are likely to be very important scientifically. On the practical side enough is now known of their effects and ways of working to be of great help in maintaining and improving our stocks of potatoes. Of the viruses themselves, it is enough to realize that they are extremely small infective agents, so small that they cannot be seen under the highest powers of an ordinary microscope. They can multiply only in living cells, and so cannot be grown and studied, (as can bacteria) in artificial media. They can increase in a plant very rapidly under favorable conditions, and when once in a plant—which also includes the tubers—the virus can never be eliminated without killing the plant. Their effect on a plant can range from death to symptoms so mild that they cannot be seen by the naked eye. They can in some cases pass from plant to plant very easily, whereas in others they need some definite means, such as a particular species of insect, to cause infection.

SEED INSPECTION STARTED

At the end of the first World War, when ideas from all countries could be brought together and considered once more, it was finally accepted that virus infection was the main, and indeed only cause of deterioration in potato stocks. At the same time it became apparent that there was a world wide danger from the spread of the wart disease, *Synchytrium endobioticum*. It was known that a large number of potato varieties were immune to this fungus pest, but at the same time even the best seed stocks sometimes contained "rogues" of other varieties that might be susceptible. The Department of Agriculture for Scotland therefore started an inspection scheme to check the varieties in seed crops and to insure that varietal purity was established and maintained. This project entailed training teams of inspectors on behalf of the Department, and of "roguers" to help the farmers. In a very short period of years remarkably pure stocks were established. Soon their health became of more importance and the seed grower gradually had "Virus" forced upon him. In the early days the diseases were classified by symptoms, and we had to cope with leaf roll and an impressive array of mosaics, ranging from rugose and leaf drop streak, through severe and mild mosaics to the mottles, and petering out with the negligible mottle, together with a good deal of argument with inspectors and on occasion, high feeling! Looking back, it seems that all the different classifications lead to confusion of the main issue, although it is difficult to see how the system could have been bettered, and the results were good without doubt. Part of the confusion arose from the fact,

which is now known, that different varieties of the potato may react quite differently to the same virus. There may be several strains and a plant can be infected by two or more viruses at the same time.

THREE VIRUSES IMPORTANT

So far as the practical grower in Scotland is concerned, it now seems that only three main types of virus need be considered. These are leaf roll, virus x and virus y, the symptoms of leaf roll will be well known to all growers, but in the best seed districts its incidence is slight, and it is more of a nuisance than a menace. In fact, it sometimes seems that it may do more good than harm to Stock Seed growers, as the extra roguing needed to insure its absence may often disclose other unsuspected faults which can be removed at the same time. The virus is known to be carried only by insects, and the so called "Peach" aphid, *Myzus Persicae*, seems to be the important carrier. An interesting fact is that once an aphid becomes infective it remains so all its life. This may explain the occasional infection of odd plants in an otherwise free stock, and house or cottage gardens can often, from experience, provide such infective material. The Strathallan Growers' Association is aiming to cut out such sources by collaboration with the gardeners and by providing them with healthy seed of suitable varieties.

Virus Y is also carried solely by aphids, but in this case the insect can carry the virus only for a short time, and soon loses its power to infect. In this district "Y" presents no problem, and it does not seem to occur in any of the better seed growing areas. Although much useful research has been done on the insect carriers of virus, there is still much to learn; if more became known about times of migration and how these vary in different districts, more positive action could be taken to reduce the effects of infection by insects in the seed growing areas at least, and perhaps also in other districts.

VIRUS X SPREAD BY CONTACT

The third class virus "X" is different, for, despite many trials, it has not been known to be carried by any insect. Sap from plants carrying the virus is very infective, and only the slightest injury to a healthy plant will allow passage from a carrier. Infection spreads only by contact, either from a plant to its neighbor through small injuries to leaves or roots, by sap from infected sprouts at dressing time, and perhaps on occasion by the carriage of infective particles from one crop to another on implements, clothing, vermin and so forth. The symptoms of virus X are most variable; usually they are so slight as to be barely distinguishable even to skilled men under good conditions; sometimes a pronounced mottle shows on the leaves, and occasionally plants are affected with mosaic symptoms which can be so severe as to be mistaken for infections with virus Y. This wide variation is known to be caused by different strains of "X", and such different strains may arise in a field crop by mutations in the virus itself. It is also known that two or more strains may exist in a plant but that only one can increase and show symptoms in any one season. Therefore, a crop which is showing very mild signs of mottle may also be carrying a severe strain, and in future years some plants may start growth with

this severe "X" is the ascendant, and show very obvious symptoms. It is the experience of seed potato growers who have been trying to turn out good stocks for a time that any stock showing a mottle will also throw occasional mosaics of various degrees of severity, and that no amount of roguing will lessen the numbers of "severes" in ensuing years. As "X" cannot be controlled by roguing, and as it does not require insects for infection, the virus is widespread and it has recently been shown that even the best Stock Seed lots grown in good areas may be completely infected. Therefore, although the effect of this virus on the yield of an individual plant is not so drastic as it is with others, its almost universal incidence makes it an important factor in the reduction of yields in good stocks in which other virus diseases are almost absent.

USE OF INDICATOR PLANTS ADOPTED

Some years ago it became apparent that the original method of stock improvement depending on roguing, inspection and certification was no longer capable of improving the best stocks, and was only serving to maintain the very great gains already made. The more severe diseases had been reduced almost to the vanishing point, and progress was not being made in cleaning up the milder forms which by that time were known to be principally caused by virus X. Now, although this virus could not be eliminated by roguing alone, owing to its variable forms and sometimes almost invisible symptoms, its presence could be detected with a very high degree of certainty by the use of certain indicator plants. It was accordingly decided at Strathallan to attempt to build up stocks free from "X" by the use of nuclear selections which had been tested for freedom on these indicators. The scheme was drawn up in 1945 after discussion and most helpful advice from plant pathologists, and it is still being worked upon without any substantial change.

In brief, the plan was to select healthy looking plants, to test sap from them for the presence of virus X and to build up the progeny of any plants which passed the test on healthy ground in conditions of isolation. The original plant selections were made during the summer of 1945 from stocks of known excellence and, as far as possible, of known origin. It is interesting to note that some of these stocks traced back to selections made by the Department under a previous plan.

During the selecting, attention was first given to the visible signs of the health of the plant and also to adjacent plants in the field. Then consideration was given to the type of growth of the individual compared with that of the whole stock from which the selection was being made. It was deemed important to build from nuclear stocks of the most desirable type for each variety, as clonal variations were already known to exist. As the selection for type could only be made by eye in the first instance, plants were picked, where possible, from different stocks, so that performance could be compared later under similar conditions. The various clones or sports that have been retained are still grown separately so that their characteristics may be observed and use made of the desirable variants. Selected plants were marked in the field with long pegs and were carefully lifted a few days before the rest of the crop. The tubers were counted and weighed, dipped in a formalin solution and stored in separate wooden boxes in a frost proof room. In 1945, the first season, 129 plants were

boxed from local stocks of the following varieties: Arran Banner, Arran Pilot, Dunbar Rover, Eclipse, Great Scot, Majestic and Sharpe's Express. During the winter more plants came in as contributions from other sources.

TEST PLANTS GROWN IN GREENHOUSE

While the selections were being chosen, preparations were being made for testing. It was decided, after consultation, to rely on *Datura Stramonium* as the principal test plant for virus X, with tobacco plants and grafts with different varieties of potatoes as checks. To grow these plants a greenhouse was built with controllable heating and insect proof ventilation. The building also included a small room for storing in numbered boxes the single plant selections of tubers and for doing the actual work of testing. These buildings were completed early in 1946. The seeds of *Datura* were sown in John Innes Compost early in March for the first test. The test was made by cutting a sprout from each tuber in a single plant box, grinding the sprouts in a mortar and rubbing the sap with a mild abrasive on a leaf of a *Datura* seedling. (Figure 1.) If virus X was present, the *Datura* showed lesions at the site of inoculation in approximately four days and a general systemic mottling within a week. In practice the test has been found to work remarkably well, and the symptoms have been easy to note. The first test disclosed that 8 per cent of the tested plants carried virus "X". This was lower than had been expected, and indeed lower than we have ever experienced with original selections.



FIGURE 1.—Potato sap being inoculated to test plant *Datura Stramonium*.

TESTED SEED PLANTED ON HILL TOP

After the spring test, the tubers from healthy plants were planted, with wide spacing between each unit, on the farm at Tullibardine Hill located on an exposed site at approximately 600 feet elevation. (Figure 2.) This land is on the edge of the heather and has not been cropped since the depression period in the latter half of the last century. In preparation for the tested stocks an area of this ground of approximately ten acres had been plowed during the previous summer and sown with a pioneer crop of rape and rye grass with a complete fertilizer and a small dressing of lime. The lime was applied both for the success of the rape and to ensure that the potatoes did not suffer from an actual calcium deficiency, which previous experience with similar land had shown to be likely. The rape was fed off with hill lambs, which were graded, and the extra price thus gained paid for the initial preparation of the land, which, after the potatoes, was ultimately sown with a permanent mixture with a full dressing of lime and minerals. The same course has been followed; since in addition to providing healthy ground for the potatoes, there has been useful food for lambs, and the final grass has been a very great improvement on what was there before.

The potatoes were planted on dung in the drill with a dressing of complete fertilizer, and as they were well sprouted, growth was rapid even on the poor, high land. During July, the second, and as we now believe more reliable test for "X", was made. In this test a leaflet from each stem of each plant in a unit was collected and the lot ground up together, as in



FIGURE 2.—Isolation plots growing at high altitude each the produce of a single plant the previous year.

the spring test, for inoculation on a fresh batch of *Datura*. These summer tests showed that some cases of "X" had been missed in the spring as a further 9 per cent of units showed reactions. That such a proportion should have escaped detection in the spring test gave us some concern at the time regarding the reliability of the scheme, but later work has shown that the summer tests with a leaflet from each stem can be relied upon, whereas the single sprout in spring, although useful, is not completely trustworthy. It seems that in mild and probably recent infections, some sprouts of a tuber may not carry the virus whereas others on the same tuber do carry it.

During the first summer more single plant selections were made, both from the tested and from outside stocks, to keep up a continuous supply of freshly selected material. During the autumn the units were lifted and boxed separately. In 1947 and the following seasons the original technique was repeated, the clones being kept separate. It was thought important to do this, because, as indicated earlier, useful variants might be established. That such variants may be found has already been proved in Tasmania, where the practice of founding virus-tested stocks is more advanced than it is in this, or indeed in any other country. In the old days, when all stocks were infected to a variable and unknown degree with different viruses, clonal variations could not be evaluated. Now, however, it is highly important that such differences should be investigated on a scientific basis.

VIRUS X FREE SEED PRODUCTION

From the start of the scheme eight years ago, it was decided to try to build up an area free from Virus X, and therefore on the two farms adjoining the test ground only potatoes of varieties known to be free from that virus were grown until a sufficient bulk of tested seed was available to colonize the extra area. It was hoped that, by following this method, we should be able to build up fairly large stocks of free material without fear of contamination from ground keepers or from infected sap carried on implements, human clothing or by crows and other vermin.

It is always well to be an optimist in anything to do with farming, and especially in any long term project, but in this matter our early hopes have even been exceeded. We have grown for the past few years an annual area of approximately seventy acres of tested stocks. On only one occasion has a plant with X been found, even after the most careful search both by our own people and by the Department's Inspectors, whose standards are rightly very stringent, and whose tests are carried out both by sap inoculation and serological methods. In view of the known high infectivity of the virus in sap and of the very large number of potato plants involved, this result is very gratifying.

Two years ago we were able to distribute small parcels of seed, about one ton each, to some of our other farms and to outside growers, in order to test how the stocks would stand up to more commercial conditions. The results were again far better than expected, and it now seems established that, in the hands of experienced and careful seed potato growers, the health of the stocks can be maintained at least over a period of years.

Lately a few enthusiastic private growers have equipped themselves for testing and the Department of Agriculture for Scotland and the National Institute of Agricultural Botany also turn out small amounts of pilot stocks. The Department has, from the first, taken a most helpful in-

terest in the project and lately it has been concerned to devise schemes to ensure the purity of the new stocks and to guard against their early contamination.

NEW CLASSIFICATIONS

For the season 1951 a new classification of seed grade "Virus Tested" was brought out. Under this, briefly the regulations laid down that; applicants must satisfy the Department that their equipment and technique were up to standard; that every plant in a stock had been tested for the first three seasons of building up, with random tests during the next three seasons; that on inspection no known virus must exist in the crop. After six years from the time an individual plant was selected, V.T. stocks have in the past been transferred to the Stock Seed category, formerly the highest grade, but the Certificate Number in the Department's Register carried a star to indicate that it was derived from tested material. Now that it has been found that these derived stocks maintain their health well in the hands of commercial seed growers, a further grade to be called "Foundation Stock" has been introduced for the 1953 season and after. The standard of inspection is very stringent and only seed from V. T. stock or Foundation Stock may be used.

It will indeed be most interesting to observe the future progress of a scheme which was first started on limited lines and with limited objectives. We already know that a good start has been made; last year, 1952, about seventy acres of V. T. stock were registered, together with approximately four hundred acres of derived material. Is it too much to hope that within a few years all our seed stocks in Scotland will be free from Virus X? It is possible, but time alone will tell.

POTASH and POTATOES

Growing potato plants will show their need for potash by leaves that have an unnatural, dark green color and become crinkled and somewhat thickened. Later on, the tip will become yellowed and scorched. This tipburn then will extend along the leaf margins and inward toward the midrib, usually curling the leaf downward and resulting in premature dying. It pays to watch for these signs, but it is a far better practice to fertilize with enough potash so as never to give them a chance to appear.

American Potash Institute, Inc.

1102 Sixteenth St., N.W.

Washington 6, D.C.

Member Companies:

American Potash & Chemical Corporation • Potash Company of America
Duval Sulphur & Potash Company • Southwest Potash Corporation
United States Potash Company



THE "STANDARD" Potato and Onion Grader

*Not only "STANDARD" but "SUPERIOR" in
Economy, Accuracy, Speed, and Adaptability.*

More Boggs Graders in use than all other makes
combined—there must be a reason. Send for our
new circular and price list.

BOGGS MFG. CORP., Atlanta, N. Y.

University Microfilms
313 North 1st St
Ann Arbor Michigan

IRON AGE BAND WAY

Potato Planters for easier planting, greater yields!



For greater accuracy and flexibility, easier planting, greater yields—no matter what your acreage or soil condition—insist on Iron Age Potato Planters and the exclusive, scientific Iron Age Band-Way method of fertilizer placement! Band-Way sows

fertilizer exactly the right distance from plants and seeds, where it does the most good. Stops fertilizer injury, leaching, fixation, burning . . . brings more plants to healthy, productive maturity . . . increases your profit per acre.

Check Iron Age's rugged construction . . . self-aligning roller bearings that mean lighter draft . . . larger, all-steel hoppers for longer life . . . and you'll see why Iron Age is your best buy! Available in one-, two-, or four-row models.

For more details, see your Oliver Iron Age dealer, or write to: THE OLIVER CORPORATION, Dept. 01, 400 W. Madison St., Chicago 6, Illinois.



PLANT AND SPRAY . . . THE IRON AGE WAY